U. S. DEPARTMENT OF AGRICULTURE,
WEATHER BUREAU.

BULLETIN No. 7.

REPORT

OF THE

FIRST ANNUAL MEETING

OF THE

AMERICAN ASSOCIATION OF STATE WEATHER SERVICES.

CO-OPERATING WITH THE WEATHER BUREAU,
U. S. DEPARTMENT OF AGRICULTURE.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Weather Bureau,
Washington, D. C., December 22, 1892.

Sir: I have the honor to transmit herewith a report of the first annual meeting of the American Association of State Weather Services co-operating with the Weather Bureau, U. S. Department of Agriculture, which was held at Rochester, New York, August 15 and 16, 1892.

As the chief object of the organization of the State Weather Services has been to increase the usefulness of the work of the Weather Bureau, and as there is so much in the report bearing directly upon the distribution of weather forecasts for the benefit of the people, I recommend that this report be published as a bulletin of this Bureau.

Very respectfully,

Mark W. Harrington,
Chief of Weather Bureau.

Hon. J. M. Rusk,
Secretary of Agriculture.

LETTER OF SUBMITTAL.

AMERICAN ASSOCIATION OF
STATE WEATHER SERVICES,
Washington, D. C., December 20, 1892.

SIR: I have the honor to submit herewith a report of the meeting of the American Association of State Weather Services co-operating with the Weather Bureau, U. S. Department of Agriculture, which was held at Rochester, New York, August 15 and 16, 1892. The report has been prepared in accordance with your suggestions, with a view to its publication as a bulletin of the Weather Bureau.

Very respectfully,

H. H. C. DUNWOODY,
President.

MARK W. HARRINGTON,
Chief of Weather Bureau.

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REPORT OF THE FIRST ANNUAL MEETING OF THE AMERICAN ASSOCIATION OF STATE WEATHER SERVICES, HELD AT ROCHESTER, N. Y., AUGUST 15 AND 16, 1892.

[Co-operating with the Weather Bureau, U. S. Department of Agriculture.]

On June 8, 1892, the Chief of the Weather Bureau addressed a circular letter to the directors of the various State and Territorial weather services, requesting an expression of opinion relative to the advisability of having a conference of the directors of such services for the purpose of discussing matters pertaining to State weather service work, the conference to be held during August at Rochester, N. Y., in connection with the meeting of the American Association for the Advancement of Science.

A second circular was issued on July 27, 1892, stating that the directors of the various services had approved the suggestion for such a convention, and that about two-thirds of the directors had expressed a desire to attend. The dates announced for the meeting were August 15 and 16, 1892, and certain subjects were suggested which it was thought would be interesting to discuss.

Responding to the invitation of the Chief of the Weather Bureau contained in the above-mentioned circulars, the following gentlemen were in attendance at the meeting:

Prof. Mark W. Harrington, Chief of the Weather Bureau; Major H. H. C. Dunwoody, Signal Corps, detailed by the President of the United States for duty with the Weather Bureau; Mr. R. E. Kerkam, Chief of the State Weather Service Division; Mr. N. B. Conger, Inspector; and Mr. F. J. Randolph, stenographer—all representing the Weather Bureau at Washington—and the following gentlemen from the States and Territories: Messrs. F. H. Clarke, Arkansas; J. A. Barwick, California; John Craig, Illinois; C. F. R. Wappenhans, Indiana; G. M. Chappel, Iowa; Frank Burke, Kentucky; E. A. Evans, Michigan; G. A. Loveland, Nebraska; J. Warren Smith, New England; E. W. McGann, New Jersey; R. M. Hardinge and W. O. Kerr, New York; C. M. Strong, Ohio; B. S. Pague, Oregon; H. L. Ball, Pennsylvania; S. W. Glenn, South Dakota; G. N. Salisbury, Utah; J. N. Ryker, Virginia; W. L. Moore, Wisconsin.

Through the courtesy of the officers of the American Association for the Advancement of Science, and of the University of Rochester,

Anderson Hall, a room in the University building, was obtained as a place for holding the meeting.

At 10 o'clock a. m., August 15, the meeting was called to order by Prof. M. W. Harrington, Chief of the Weather Bureau, as temporary chairman of the association, who delivered an address of welcome to the representatives present. He spoke in high praise of the important work which is being done by the State weather services co-operating with the Weather Bureau, and stated that the object in suggesting this meeting was to bring the State weather services closer together and to give the directors an opportunity to discuss important questions pertaining to the policy and administration of these services. He suggested that the representatives take charge of the convention, give it a name, elect its officers, arrange its programme, etc.

The association then proceeded to effect an organization, and the following committees were appointed: Committee on constitution and permanent organization, on nomination of permanent officers, to consult with the local secretary of the American Association for the Advancement of Science, and on programme.

The association then adjourned until 3 p. m.

The first business of the afternoon session was the adoption of the report of the committee to consult with the local secretary relative to the character of badge for the association, recommending a white silk ribbon, with a design of the cold-wave flag at the top, and the words "Association of State Weather Services" printed below.

The committee on nomination of permanent officers made their report, which was adopted, and the following officers were then elected: President, Major H. H. C. Dunwoody; First Vice-President, Mr. B. S. Pague, of Oregon; Second Vice-President, Dr. G. M. Chappel, of Iowa; Secretary, Mr. R. E. Kerkam, Chief of the State Weather Service Division of the Weather Bureau; and Treasurer, Mr. W. L. Moore, of Wisconsin. The officers thus elected were then installed.

The committee on constitution and organization then submitted its report, which, after being discussed and slightly amended, was adopted in the following form:

CONSTITUTION.

Article I, Section 1. This association shall be known as the American Association of State Weather Services, and shall be composed of the directors of the several State and Territorial weather services of the United States and officials detailed for State weather service duty, the Chief of the Weather Bureau, chief of the State Weather Service Division of the Weather Bureau, inspectors, and higher officials of the Weather Bureau connected with the State Weather Service Division of the Weather Bureau.

Section 2. Other members may be elected by a two-thirds vote of the members present at a regular meeting of the association.

Section 3. Observers and assistant observers of the United States Weather Bureau, and other persons directly interested in State weather service work, may be elected honorary members by a two-thirds vote of the members present at a regular meeting of the association.

ARTICLE II, Section 1. The regular meetings of this association shall be held annually on the Monday and Tuesday preceding the meeting of the American Association for the Advancement of Science, and at the place selected by that association.

Section 2. Special meetings may be called by the president of the association by and with the consent and approval of the Chief of the Weather Bureau.

ARTICLE III. The officers of this association shall consist of a president, two vice-presidents, a secretary, and a treasurer, and they shall be elected at each annual meeting.

ARTICLE IV. Amendments may be made to this constitution only at a regular meeting of the association by a two-thirds vote of the members present after specific notice has been given.

BY-LAWS.

1. That the secretary, after consulting with the president and first vice-president of this association, shall prepare the programme of each annual meeting, and furnish a copy thereof to each member six weeks before such meeting.

2. That these by-laws may be amended at any regular meeting of the association by a two-thirds vote of all the members present.

SUBJECTS FOR DISCUSSION.

The organization of the association being thus completed, it was decided to take up the subjects for discussion, and the following programme was announced by the committee on programme and adopted by the association:

1. Instrument shelters for voluntary observers, and their location.
2. Shall all voluntary observers use self-registering thermometers (maximum and minimum), and means be computed from such readings?
3. The best form for monthly report for voluntary observers—to be of a size suitable for manifolding three or four copies by an indelible carbon process, saving the observer much time.
4. Thunderstorm observations and forecasting of such storms.
5. Should not voluntary observers be chosen as cotton-region, river, and special rainfall observers whenever practicable?
6. A uniform manner of publishing the weekly, monthly, and annual reports of State weather services.
7. The best method of signaling forecasts by displaymen.
8. Inspection of stations of voluntary observers.
9. Relation of State weather services to agricultural colleges and experiment stations.

FIRST SUBJECT.

Instrument shelters for voluntary observers, and their location.

The discussion of this subject was characterized by a unanimous expression of opinion that each voluntary observer should have a shelter in which to expose his instruments, not only as a protection

to the instruments, but that observations of instruments in shelters would be far more valuable than those now made without uniformity as to place or manner of exposure. Cases were cited in which observers had selected most unsuitable places in which to locate the instruments, which rendered the observations almost valueless, and exposed the instruments to constant danger of breakage. There were slight differences of opinion as to the style and dimensions of a shelter which should be generally adopted by all State weather services, but a shelter such as is used by the Weather Bureau for issue to cotton-region observers was generally considered to be most suitable. A number of such shelters are already in use by voluntary observers and are reported to be entirely satisfactory. In some cases they had cost from $8 to $10, while in Michigan they had been made, painted, crated, and ready for shipment for $5 each, in lots of ten, and it was believed that by ordering fifty or more they could be made for $3.50 or $4 each.

It was the prevailing opinion that uniformity as to location and elevation should be secured, if practicable. Some representatives thought that uniformity could best be had by exposing the shelter on the north side of buildings, but a majority of the gentlemen were of the opinion that a shelter exposed over sod would give decidedly more accurate results, and that the height of the shelter should be such that the instruments could be read by an observer while standing on the ground.

The subject was considered one of very great importance, and was finally disposed of by the appointment of a committee of three, consisting of Messrs. Moore, Smith, and Pague, to investigate the subject and report to the president of the association the style of shelter most suitable for general adoption by the various State weather services. (For report see Appendix A.)

The association having taken a recess until 8 p. m., the session was called to order at that time, and the second subject was presented for discussion.

SECOND SUBJECT.

Shall all voluntary observers use self-registering thermometers (maximum and minimum), and means be computed from such readings?

All gentlemen who spoke upon this subject favored the use of the self-registering maximum and minimum thermometers by voluntary observers, and thought that their use should be encouraged. While the value of the dry or dry and wet thermometer readings was fully acknowledged, and the record of relative humidity was considered of great importance and such observations should not be discouraged,

yet a variety of reasons were stated why all voluntary observers should, if practicable, make observations of the self-registering maximum and minimum thermometers. Among the arguments brought forward in favor of the use of these thermometers were: Their readings would furnish, in addition to a quite accurate daily mean, the extremes of temperature, which were thought to be of very great value, especially in considering climatic conditions with relation to crop production. They would insure more reliable data, as it was thought that few observers are always able to take the tri-daily observations at the hours specified. They would very greatly reduce the amount of labor on the part of the observer as compared with the other system, as only one observation a day would be necessary, and for the same reason the liability of error in taking and recording the readings would likewise be diminished.

It was determined by a vote that it was the sense of the association that the use of maximum and minimum thermometers should be encouraged, and that when used the daily means should be computed from such readings.

THIRD SUBJECT.

The best form of monthly report for voluntary observers—to be of a size suitable for manifolding three or four copies by an indelible carbon process, saving the observer much time.

The secretary submitted and explained a form which he had devised for use of voluntary observers, which might be issued in place of the present Form No. 1009, Voluntary Observer's Monthly Report. These forms are printed on thin paper and bound together in the manner of a book. By means of indelible carbon paper and a stylus an observer can make several copies of the form at a single writing, thus enabling him to furnish original and exact copies of the monthly report to the State and National services, to the local press for publication, etc., without the labor of copying. Copies of the form prepared for manifolding had been sent to twelve voluntary observers for test, and all reports received from them had been favorable to their use.

After a brief debate upon the subject, a committee of five was appointed to consider and recommend a monthly form most suitable for use of voluntary observers. In reporting upon the subject the committee recommended the form and duplicating process suggested by the secretary with the addition of a column for the daily range of temperature, as the one most suitable for voluntary observers, and this report was favorably received and adopted by vote of the association. The form as adopted provides for the following data: The 7 a. m., 2 and 9 p. m., and the maximum and minimum thermometer

readings, the daily mean and daily range of temperature; the time of beginning, time of ending, and amount of precipitation and snowfall, in inches; prevailing direction of wind; character of the day; and a monthly summary of the elements above mentioned, as also dates of occurrence of special phenomena, such as frosts, hail, sleet, auroras, etc., providing also for remarks on thunderstorms and miscellaneous phenomena.

FOURTH SUBJECT.

Thunderstorms and forecasting of such storms.

The remarks upon this subject consisted mainly in an account of the experience of the gentlemen who, during the past season, were charged with the duty of collecting reports of thunderstorms and issuing forecasts or warnings of their approach. While no definite conclusion was arrived at in the discussion, on account of the investigation being in progress, it was the consensus of opinion that thunderstorms can be successfully forecasted from the a. m. or p. m. weather maps and distributed throughout the various districts in time to be of benefit to the general public. The plan of sending special telegraphic messages of the occurrence of thunderstorms to stations east of the place of occurrence has not proved successful, as the reports of a majority of the observers having charge of this work show that thunderstorms may occur in the States east at the same time that they prevail at the station sending the special message. For instance, a thunderstorm may occur in Wisconsin and Illinois, and before a message can be sent to the distributing center in Michigan or Indiana a thunderstorm will have occurred in each of those States, thus proving that the belt of thunderstorms is so extended that the messages are not found to be of particular value. The majority of the observers reported that in the greatest number of cases the thunderstorms were forecasted in the morning and the forecasts proved successful, covering the same territory and in the same manner as forecasts of rain.

It was the general opinion that the investigation of this important subject has not been carried on a sufficient length of time or over a sufficiently extensive area of country to permit a definite conclusion as to what extent the forecasting of thunderstorms may be practicable. From the remarks of the gentlemen who had handled the thunderstorm reports during the past season and had observed their characteristics, it would appear that thunderstorms may occur simultaneously over a large portion of a State but without any progressive movement being apparent. In most cases these were found to be what are termed heat thunderstorms. The second series of storms have the ideal movement, being first reported in the western portion

of a State and their progressive movement across the State being quite regular. It had also been observed that thunderstorms attending a well-defined area of low pressure usually occur in the southeast quadrant and follow the general course of the storm, moving, however, more to the northward. The thunderstorm track, if prolonged, usually intersects the storm track within the region of disturbance. Such storms move with considerable uniformity from west to east or from southwest to northeast. When there is no general storm movement, and when the conditions are apparently stationary during the hot season, thunderstorms may occur over a wide area, and almost simultaneously, as has been observed during the present season. The general opinion was that their velocity is from twenty-five to thirty miles per hour, although instances were reported of their moving from sixty to eighty miles per hour.

The different system inaugurated in Michigan for test on telephone lines seemed to be more perfect in its operation than the telegraphing from stations west to those east, as upon the occurrence of a thunderstorm in the State its intensity and direction were immediately reported to the central office from the district in which it occurred, so that the forecaster at the central station could give notice to sections in advance of the storm in time to be of practical value. It was the opinion that when the telephone system is expanded, its use for this purpose will be feasible, and that it can be made of no little value to the public in giving timely warning of the approach of thunderstorms. It was also stated that sometimes thunderstorms, in their movements, seemed to die out or, as was explained, to pass over one section and be reported in another to the east and move along for a short distance and then disappear again and then reappear farther on; so that some were of the opinion that a storm may originate, move for a few miles, then, losing its intensity, disappear, only to reappear in another section where the conditions may again develop with sufficient force to culminate in a thunderstorm.

Several important papers were heard on this subject, but the association took no definite action, believing that it should be further investigated, and it being understood that an official report of the investigations of such storms would be submitted later which would cover all the points discussed at the meeting.

At 10 p. m. the association adjourned until the following morning.

The association was convened at 10 a. m., August 16, and the following was announced as the next order of business:

FIFTH SUBJECT.

Should not voluntary observers be chosen as cotton-region, river, and special rainfall observers whenever practicable?

This subject was briefly discussed, but the consensus of opinion was that voluntary observers should, whenever practicable, be chosen as paid observers, as men who, having voluntarily performed the duties of observers and having thereby demonstrated their interest in the work, will prove much more valuable as paid observers than those who engage in the work only for the compensation which they obtain, and this opinion was expressed by a motion which was passed by the association.

SIXTH SUBJECT.

A uniform manner of publishing the weekly, monthly, and annual reports of State weather services.

The advantage of a uniform style of publication for the various reports of State weather services was acknowledged by the gentlemen who participated in the discussion of this subject, as, if this were accomplished, it would be possible to have the reports of each service bound, either separately or in a series embracing the reports of all State services, and in this way complete files of such reports could be had by each service and by the Weather Bureau in a form which would make them convenient for reference. But the discussion clearly developed the fact that it would scarcely be possible to prescribe a style of publication, in which the size of the book, the number of pages, the arrangement of the tabulated data, and the general character of its contents would be specified, and to which the reports of the various services could be made to conform. In the case of State services receiving State or other local support, the character of monthly and annual reports is frequently prescribed either by the State law or by those having authority to control the publication of such reports. It was suggested that the association might adopt the style of publication which would be desirable, and wherever it was found possible the State services could conform to it. A motion was therefore made that uniformity in the published reports of State weather services is desirable, which motion was carried.

SEVENTH SUBJECT.

The best manner of signaling forecasts by displaymen.

While it was thought that the flag and whistle signal systems are fairly satisfactory in a general way, yet they were considered to be so far from perfect that it is quite desirable to secure a system which

would overcome some of the disadvantages of those now in use. In localities where high wind velocities prevail the signal flags soon wear out; and, on the other hand, in States where light winds are prevalent the flags cling to the mast or pole and the signal cannot be understood. In sections where manufacturing is extensively carried on the flags are frequently so discolored by coal smoke that the white flag cannot be distinguished from the blue one. It was also stated that while, under favorable conditions, whistles can sometimes be heard a long distance, and that the chime whistles are becoming quite popular as means of disseminating forecasts, still the whistles are not always available at points where it is desired to establish a display station, and under some conditions they are not altogether satisfactory. Therefore, the members of the association desired, if possible, to recommend some improved system of signals which would obviate the difficulties and defects of the present system.

Several suggestions were made of signals which might be made to answer the purpose required, and their merits or demerits were freely discussed. The representative of the New England service explained to the association a system of signals which had been devised by Mr. W. B. Kendall, of Bowdoinham, Me. This consists of a tall mast, strongly guyed and rigged with wire rope and pulleys for hoisting large wire-work balls of from eight to twelve feet in diameter, and provides for the hoisting of one ball to indicate fair weather, two balls for cloudy weather and showers, and three balls for rain. No provision is made for temperature forecasts, excepting for the occurrence of frost and cold waves, which may be indicated by a long pennant flying from the top of the mast. The plan is to erect poles on high hills where the balls will be outlined against the sky and where they may be seen for a radius of six or eight miles.

The probable high cost of this apparatus was one of the objections urged against it, and the absence of a means of indicating temperature forecasts was also thought to be an objection.

What is known as the Pusey system of weather signals was also described to the association. This signal device consists of two essential members; the one a horizontal bar or vane, the other an arm having at its free end a disc, which arm is rotatable in a plane parallel with that of the vane, that is, adapted to turn towards or away from the latter, and fixed in any position in the arc in which the arm rotates. The entire device is pivoted to turn with the wind. Such position of the arm or disc indicates the weather. If turned towards the vane it means "rain or snow," and if turned away from the vane it indicates "fair weather." The position of the disc with relation to the horizontal indicates temperature; if above the vane, it indicates "higher temperature;" if horizontal, "stationary temperature;" and if below the vane, "lower temperature." The signals

being dependent upon well-defined positions, and not upon colors, they may be read in all weather and at comparatively long distances.

It was claimed for this system that it is simple, durable, and costs only about $10, which is about the cost of a good set of flags. It was thought that there was nothing about it to get out of order, and the apparatus would last about six years. It was stated that in a test which had been made of the apparatus it was found that the vane would not conform to the direction of the wind in the manner of a wind-vane, but that that feature could doubtless be remedied.

Signals made of tin were suggested, and it was reported that such signals had been used in Ohio for over a year and are now in as good condition as when they were put up.

The throwing up of colored lights by means of bombs was also referred to, but it was stated that they had been formerly tried and had not proved a success.

Reference was also made to the search light as a means of disseminating forecasts by throwing a flash or beam of light on a cloud in the sky, and in fact experiments had shown that such a flash would be visible with a perfectly clear sky. This means of displaying weather forecasts was regarded as very interesting and likely to prove valuable, and it was stated that it is proposed by the director of the experiment station in Massachusetts to construct an electric search light by means of which forecasts will be signaled.

In consideration of the importance of the subject it was referred to a committee, consisting of Messrs. Conger, Glenn, and Kerkam, with instructions to consider and recommend the best means of signaling weather forecasts by displaymen, and to submit their report to the president of the association. (For report of committee see Appendix B.)

EIGHTH SUBJECT.

Inspection of stations of voluntary observers.

The proposition to inspect voluntary stations was most heartily indorsed by all the gentlemen who participated in the discussion of the subject, and the opinion was freely expressed that periodical inspections of such stations by a representative of each State weather service would go far towards improving the value of the observations furnished by voluntary observers, and to greatly enhance the popularity of State weather service work. The association was told of the great good that had resulted from the inspections in a few States where they have been made to a greater or less extent, how the flagging interest of many voluntary observers had been revived upon meeting the director or assistant director and receiving from him information as to the value of the observations, the great

and increasing usefulness of State weather service work generally, and being carefully instructed as to the details of his work, the proper manner of setting up and exposing the instruments, etc. It was believed that the interest of the community in State weather service work could be aroused by meeting and conversing with the prominent citizens and editors of newspapers at the stations, and by visiting farmers' institutes and distributing weather charts, bulletins, and reports, and explaining the same. It was also suggested that the information which could be obtained by the inspector relative to the elevation of stations, the topography of the country, the character of the soil, the best means of communication by wire and rail, etc., would be of much value to the State and National services. It was thought that the Weather Bureau might grant its observers, detailed upon State weather service work, thirty days annually for the purpose of inspecting the voluntary stations, together with a pecuniary allowance sufficient to defray the necessary expenses.

A motion was submitted and carried, expressing the opinion of the association that an inspection of the voluntary stations should be made annually under the direction of the Chief of the Weather Bureau, it being the opinion of the association that such inspections would result in great advantage to the State and National services.

At 12 o'clock noon the association adjourned until 3 p. m.

After the noon recess the following subject was presented for discussion:

NINTH SUBJECT.

The relation of State weather services to agricultural colleges and experiment stations.

As an introduction of this subject for discussion Professor Harrington stated that it was one of very great interest to the central office at Washington. It had frequently been suggested that the State weather service centers should be located at the experiment stations or agricultural colleges, it being claimed that such action would result in advantage both to the agricultural interests and to the State weather services. It has also been alleged that as most of our observations are taken on the tops of high buildings they are not suitable for agricultural purposes. On the other hand it is affirmed that the great meteorological map and forecast work could not be carried on at the experiment stations and colleges, as they are generally situated at places remote from the necessary facilities for properly conducting the work which, for a variety of reasons, must be done at the large centers. The question has had to be considered

frequently, and more light is desired upon it. He thought there must be advantage in having closer relations between the two branches of work, but he was not quite certain as to what those relations should be, and would be glad to hear suggestions.*

Discussion of the subject developed the fact that the State weather services are cheerfully co-operating with the experiment stations and agricultural colleges in furnishing such meteorological and crop data as is desired, and in recommending the furnishing of instruments for observation at those places wherever the services of an observer can be procured. The data collected by the State services are available for the use of the agricultural institutions, and the directors of the two branches are in some States jointly carrying on investigations involving questions relating to the effect of weather upon crops. It was almost the unanimous opinion, however, that it would be impracticable to locate the central stations of the State weather services at the experiment stations or agricultural colleges, mainly owing to the lack, at nearly all such places, of the telegraph and mail facilities necessary for the collection and dissemination of the information and reports in time to be of practical value to the community.

It was the sense of the association, as expressed in a motion which was passed, that the State weather services should co-operate with the agricultural colleges and experiment stations in the collection of meteorological data and the publication of the same with mutual benefit to both services.

Exhibit at the World's Fair.

This subject was brought before the association in order to ascertain what preparation is being made looking to an exhibit of State weather service work at the Columbian Exposition. Professor Harrington stated that he had been informed that the space in the building to be occupied by the Weather Bureau exhibit will be so limited that it is thought it will not be possible to provide space for special exhibits of the various State weather services, and therefore it might

* As to the statement that the observations as carried on at our central stations—in the centers of cities and on the tops of high buildings—are unsuitable for the use of agriculturists, a great deal may be said in palliation. Cities, as such, have very little effect on the observations taken within them, an effect so small that even for such a city as London, England, scores of years of observation are necessary to bring it in evidence in the means of the important meteorological elements of temperature and rainfall. The covering of smoke has a well marked effect on the extremes of temperature, but this being once learned the forecast official can predict frosts from the city as well as from the country. The elevation has an effect on temperature and velocity of the wind, but this can be determined and allowed for. Recent studies show that the catch of rainfall is not sensitive to moderate elevations, but is very sensitive to wind-breaks and eddies. A roof exposure for a rain-gauge may, if properly chosen, be better than one on the ground in a court, or among bushes or trees.—M. W. H.

be well for each State service to have a full and complete display in the State building.

While no definite plan was suggested as to what should constitute the exhibits, it was evident from the remarks of the gentlemen that the plan contemplated by those who have already commenced the preparation of the exhibits is to display carefully constructed charts of each of the more important meteorological elements in such manner as to graphically present the climatology of each State; charts showing the location and character of the various State weather service stations, such as voluntary meteorological stations, weather signal display stations, frost and cold-wave warning stations, etc., while the crop bulletin work will be illustrated in an appropriate manner.

No formal resolution was offered expressing the sentiment of the association on the matter, still it was clearly the desire of the members that each State service should arrange for as creditable an exhibit as possible, and that such exhibit be located in the State building.

As no other general subject was suggested for discussion it was decided to proceed to the election of gentlemen proposed for active or honorary membership of the association.

Election of Active Members.

Messrs. E. T. Turner and W. O. Kerr, of the New York Weather Service, and Mr. E. H. Nimmo, of the Michigan Weather Service, were proposed and elected to active membership.

Election of Honorary Members.

A motion was unanimously passed by the association providing for the election of all active voluntary observers of the various State and Territorial weather services as honorary members of the association, and that such members be notified of their election by the director or assistant director of each State weather service.

The following were also proposed and elected as honorary members: Mr. Edwin F. Smith, secretary California State Agricultural Society, Sacramento, Cal.; Mr. Richard V. Gaines, Mossingford, Va.; Prof. R. Ellsworth Call, Des Moines, Iowa; Mr. Charles H. Nauck, Deputy Commissioner Arkansas Bureau of Mines, Manufacture, and Agriculture, Little Rock, Ark.; Prof. W. H. Niles, Institute of Technology, Boston, Mass.; Prof. G. H. Whitcher, member of the Board of Governors, New Hampshire Agricultural Experiment Station, Hanover, N. H.; Mr. H. G. Reynolds, secretary State Board of Agriculture, Agricultural College, Mich.; Mr. H. F. Alciatore, Weather Bureau, Portland, Oregon; Prof. Louis McLouth, president South Dakota Agricultural College, Brookings, S. Dak.; Mr. C. F. Schneider, Weather Bureau, Detroit, Mich.; and Prof. A. L. McRae, Rolla, Mo.

Votes of thanks were extended to the temporary chairman and president of the association for the courteous and able manner in which they had presided over the proceedings of the meeting, to the American Association for the Advancement of Science, and to the officials of the University of Rochester for the courtesies extended to the members of the association during their stay in the city.

There being no further business before the association a motion was made that the association adjourn *sine die*.

The president desired, before putting the motion, to congratulate the members upon the very successful meeting. He believed that each member would return to his post of duty better able to carry on the work of his State service than he was before the meeting. In his opinion the National service would be benefited, and the people of the country receive substantial benefits from this feature of scientific investigation to be carried on in connection with the American Association for the Advancement of Science. He thought that before adjourning the members would be glad to hear from Professor Harrington.

Replying to this call, Professor Harrington stated that the president had said so much and so well that very little remained for him to say. He had been very much gratified with this meeting. It had been an experiment, having been suggested by the Secretary of the Association, and he himself had thought that there ought to be some means of bringing the State weather services closer together, yet it was with some hesitation that he had consented to call such a meeting. He had also some hesitation in calling the meeting in connection with the American Association, as he did not know whether it would be agreeable to the directors, but all doubt on these points had been removed since the meeting of this association. He thought the meeting had been a decided success, and that the benefits of it would be felt, not only by the State services, but by the National service. He believed that all had been interested and instructed by the discussion which had been carried on, and he trusted that the representatives would return to their work with renewed energy and prospects of increased success, and that the State weather services would continue to grow in usefulness.

The association then, at 6 o'clock p. m., adjourned *sine die*.

APPENDIX A.

REPORT OF COMMITTEE ON INSTRUMENT SHELTER.

NOVEMBER 5, 1892.

To Major H. H. C. DUNWOODY,
President American Association of
State Weather Services, Washington, D. C.:

SIR: Your committee appointed to consider the subject of the "most suitable instrument shelter and manner of exposure to be generally adopted by State weather services" have the honor to submit the following report:

We have considered, first, exposure, with a view to securing free open air readings; second, such a shelter as will properly protect from solar and terrestrial radiations, reflected heat, etc., and still not be too expensive for general adoption.

Difficulty is found in reconciling the opinions of different members of the committee into a unanimous recommendation as to any particular pattern of shelter or the elevation at which it shall be exposed. Papers by Mr. J. Warren Smith, Mr. B. S. Pague, and Prof. H. A. Hazen are forwarded with the request that they be published with the report.

The papers of Messrs. Smith and Pague contain plans of shelters which, with the plan proposed further on in this report, are recommended for test by the Weather Bureau at Washington, D. C., one of each to be constructed and comparative readings made at elevations varying from 4 to 10 feet over sod in level, open field. If the shelter proposed by Mr. Smith, or the one by Mr. Pague, shows better results than the one herewith suggested, said shelter to be considered as the standard in place of the one now recommended. It is admitted by all that a standard Weather Bureau shelter, exposed at an elevation of 10 or 15 feet over sod, will give a true temperature reading, air drainage not being considered, but economy in construction and covenience in gratuitous readings of instruments prompt us to seek for the cheapest and simplest construction and lowest elevation consistent with accuracy. If your committee had the funds to construct patterns of the several shelters herein referred to and time and opportunity to carefully test them, they would ask leave to hold this report until after such test could be made. Probably this could be better done at the central office, where some competent official could be designated to give his whole time to the matter for a considerable period.

Nothing can be said in favor of the window or wall shelter, except that it can be cheaply made. Most buildings are protected by trees or other buildings which obstruct the free air circulation; the building itself is always a potent influence in restricting air currents, and in establishing local temperatures that are not common to the surrounding air. Some observers are using the wall or similar shelters, and for want of funds probably no immediate change can be made, but as opportunities offer the standard shelter and exposure might be substituted. The tree exposure should not be thought of, for at one season foliage is dense and at another there is none. Even with a thick covering of leaves there will always be an occasional sun ray to pass entirely through. If the instruments are not protected on all sides by a board shelter, some of these penetrating rays will, at times, impinge upon it and vitiate the readings. Hence, just as complete a shelter will be here needed as in the open field, and the only agency of the tree is to interfere with natural ventilation.

RECOMMENDATION.

If it should not be thought practicable by the Chief of the Bureau to direct the making of the test suggested, then your committee, with their present knowledge of the subject, respectfully recommend the adoption of a modification of the design shown on page 22 of "Instructions for Voluntary Observers;" that the inside back vertical measurements be 26 inches in the clear and the base a rectangle 26 x 18 inches; that it be exposed over sod on ground as nearly level as possible, at an elevation of 4½ feet for the bottom of the shelter, or about 5½ feet for the pins supporting thermometers.

A width and height of 26 inches will allow the maximum thermometer to swing with an inch margin all around. As economy is an important factor, we believe that the depth of 3 feet in the present standard shelter can be reduced to 18 inches without in any way impairing the accuracy of the readings.

This will give room for the maximum and minimum thermometers and for the dry and wet bulb instruments; the dry and wet bulb, of course, to be placed one or two inches back of the plane in which the maximum swings. As few, if any, voluntary observers use the whirling psychrometer, it is not necessary to allow space for that purpose.

The immediate effect of ground radiation at night and reflection by day in air gently in motion, is inappreciable at an elevation of 4 feet. With instruments at a height of 5½ feet placed at least 50 feet from trees or buildings and care exercised to avoid air pockets which may collect the cold air by drainage from higher ground, such readings will be secured as will be of the greatest value to climatological students, to the agricultural interests, and especially will they be such as are needed by local forecast officials in studying local county conditions in their frost-warning work.

Readings can be taken by observers standing on the ground, and the instruments will be in the line of vision of a person of average height.

The shelter can be exposed on a flat roof where an open sod exposure can not be secured, but in that case it will be necessary to lay a platform 20 feet square, and to have shelter at the same elevation above platform as provided for sod exposure. But the sod exposure should be considered as the standard. In fact there are so few voluntary observers using roof exposure that it is hardly worth while to consider it.

An offer is in the hands of your committee from a sash and blind factory of Milwaukee, Wis., to manufacture the shelters at $6 apiece, boxed and delivered on cars. By having several State services, covering contiguous territory, combine in their purchase of shelters, and order from a factory that has been induced to make a low price in consideration of the number sold, a minimum price and uniformity of construction will be secured. It was by representing to the Milwaukee firm that probably Michigan, Iowa, Illinois, Minnesota, and the Dakotas would order from them that this rate was given. They also thought that if orders were numerous enough to justify them in getting out at one time by machinery lumber enough for 25 or 50 shelters the price could be brought down to $4 each.

Very respectfully,

W. L. Moore.
J. Warren Smith.

I concur in this report with the exception as to the elevation of the bottom of the shelter; 4½ feet is entirely too low an elevation for the bottom of the shelter; a man 5 feet 10 inches in height would have to stoop over to read the thermometer. A box or cheap step can easily be secured to raise the observer 3 feet, and then having the bottom of the shelter 7½ feet above the ground would raise the thermometer to about 8 feet 10 inches, which is certainly none too low to escape effect of radiation, etc.; therefore, substituting 7½ feet for 4½ feet elevation of bottom of shelter, I concur in this report.

B. S. Pague.

Paper by J. Warren Smith, Director New England Weather Service, Boston, Mass.

Fig. 1 shows a shelter with the instruments in position that, if found accurate after testing, will combine cheapness with simplicity. For ordinary voluntary observer work the shelter should be about 3 feet long and 2 feet wide on the bottom, with the sides 2 feet in width. Both sides and ends should be made with ordinary lattice work. The side posts may be made of 2 x 4 pieces, and should go to

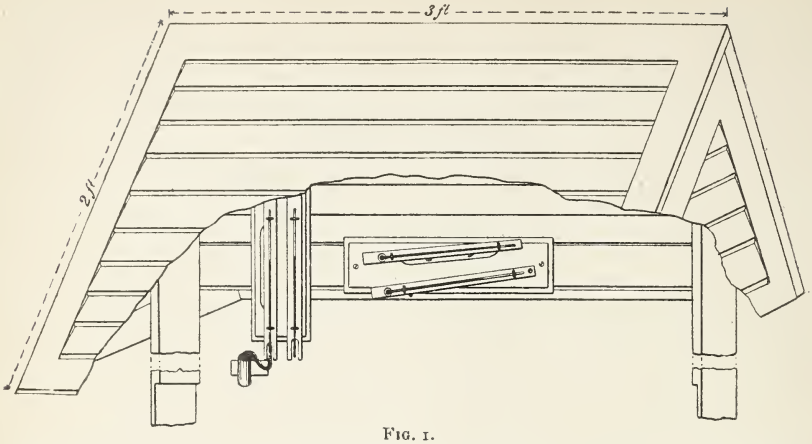
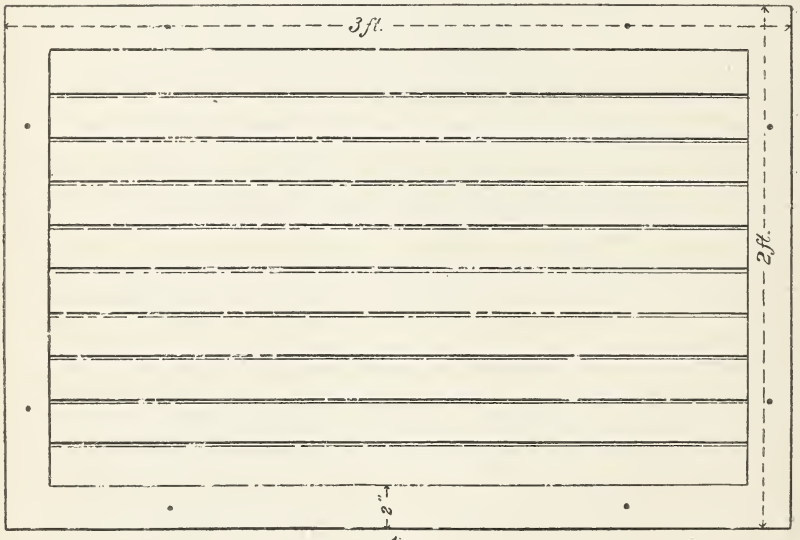


FIG. 1.



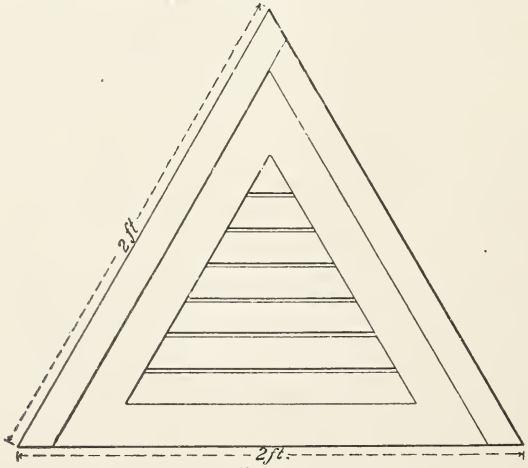


FIG. 2.

the top of the shelter to give it strength. The lower ends of these should be about 18 inches below the shelter and fitted with holes for bolting to posts in the ground, all to be of such height that the eye of the observer will come on a level with the thermometers while standing on the ground, or on one step above the ground. The piece running across to support the thermometers should be attached to the back side of the posts so as to bring the thermometers nearly under the middle of the shelter. If found necessary for protection a wire netting can be placed for the bottom, with a hinged door for letting down, or a wooden lattice-work bottom may be put in.

Fig. 2 shows a front view of one side piece and the end view of the shelter. Unless the Chief of the Bureau can see serious objections to this shelter, I recommend that it be thoroughly tested.

J. Warren Smith.

Paper of Mr. B. S. Pague, Local Forecast Official, Weather Bureau, Assistant Director, Oregon Weather Service.

The proper exposure of thermometers is the most important feature connected with State weather service work. Every voluntary station should be inspected, and all thermometers have the same exposure throughout the United States. As it now is the climatology of the United States is based on Weather Bureau observations, which do not give the true temperature of the country, but rather that of the city. From personal experience I have found the minimum temperature in the city of Portland, Oregon, to be from 2° to 4° higher than the minimum temperature surrounding the city. Hence, we must first select the location for the instruments and then determine the height above the ground. As a rule, voluntary observers do not use roof exposures, hence roof exposures need not be considered.

Sod exposures should be adopted. There should be as free and perfect ventilation as possible. The thermometers must be protected so that they will not become wet.

It sometimes occurs that a sod exposure cannot be had, in which case it would be well to adopt an exposure on the north side of a building. In selecting locations for exposure it should be borne in mind that positions on a knoll, at the foot of a hill, in a valley, etc., prove causes of inaccuracies. The position should be such as to have the air current and not the local influences which are potent factors. The shelter itself is the main subject for consideration in this report. The standard Weather Bureau shelter answers all purposes, but for voluntary observers it is too expensive; hence a suitable one should be devised. The one mentioned at the Rochester meeting as being used by several voluntary observers in Oregon is satisfactory, cheap, and answers all purposes. It consists of four boards, two of them 8

inches wide and 15 inches long, the other two 6 inches wide and 15 inches long. When put together it appears as shown in Fig. 3.

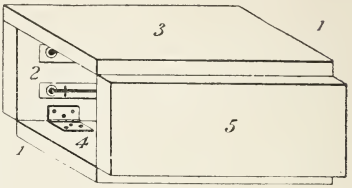


Fig. 3.

The ends, "1," are open, "2, 4, and 5" are perforated with auger holes slanting upwards, and "3," the top, is not perforated, but is a plain board. Open it appears as shown in Fig. 4.

Number "3" (when open) is used as a lid. On the under side (top side when open) a rubber band is stretched across, and that is used to slip the form and pencil underneath, having them both always convenient. Number "2" has thermometers attached.

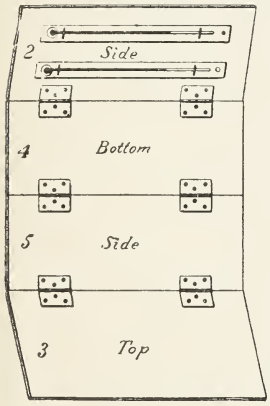


Fig. 4.

This is a small, but convenient and inexpensive shelter. It is suitable to the north side of a building or a tree or other shaded exposure, and is the next best thing to a standard shelter.

For the standard shelter pattern I deem it necessary to have the double roof. The depth of the shelter can be reduced to 18 inches without detriment. In such a case the door should open on the north side and the thermometer should be placed in the shelter 12 inches from the back; thus allowing farther distance for the thermometers from the continued sunshine on the south side of the shelter. The bottom should be made solid, *i. e.*, not latticed but closely nailed boards. The height of the shelter needs careful study. In Oregon, when possible, the shelter is 12 feet above the sod. This may be rather high, but before the height is reduced below 9 feet most careful experiments should be made. Lower elevation will most certainly allow of inaccurate effect of radiation.

In connection with my idea on this subject, I attach a report prepared, in compliance with a personal request of mine, by Prof. H. A. Hazen, Weather Bureau, by direction of the Chief of the Weather Bureau, to whom the paper of Professor Hazen was submitted before being forwarded to me. Many of the ideas advanced by Professor Hazen coincide with mine, which I have found in actual work. I would recommend that the paper of Professor Hazen be published, or so much of it as meets with the views of the committee.

B. S. Pague.

Paper by Prof. H. A. Hazen on exposure of thermometers by voluntary observers.

I shall not consider the very small per cent. of exposures required for the college or amateur observatory. For a roof exposure or one in the open at a height of 10 to 15 feet above sod, the present standard shelter can not be improved upon—it certainly should not be any smaller.

The points to be considered are: First, accuracy; second, convenience; third, expense.

ACCURACY.

I am inclined to think that very erroneous opinions are entertained in England and on the continent as to proper methods of exposure. The Stevenson stand, about 18 by 12 by 18 inches, with double louvers, and exposed 4 feet above sod, would give in our latitudes temperature 4° to 5° too high in bright sunshine. This has been tested. The reason why this has met with so much favor abroad is that that country is 600 to 800 miles farther north than this and does not have the insolation that we have.

An examination of the temperatures observed by voluntary observers will show a serious lack of accordance with those of the regular stations, and it is an interesting fact that with but few exceptions they are higher. This is accounted for from the fact that many of these thermometers are in porches or in summer houses, or in angles where they get little or no air circulation. At Amherst, Mass., there is or was a very elaborate and close low house built at great expense. It looked handsome but was totally unsuited for its purpose. In another case the voluntary observer placed his thermometer in an unused room with windows open. I would like to lay down a few propositions to insure accuracy in a thermometer exposure:

First. There must be as free and perfect a natural ventilation as possible.

Second. An occasional wetting of the thermometer is unobjectionable, and this should not be guarded against to the detriment of (1).

Third. Uniformity—that is, there should be two or three exposures decided upon, and so far as possible insisted on in every case.

Fourth. It should be noted that in most of the cases of inaccuracy it is not due to the immediate environment, but to the position of a house on a knoll, at the foot of a hill, in a valley, etc. An investigation will show that this cause is far more potent than any improper exposure, and it is easy to see that no shelter whatever can ever remedy this evil due to topography.

Fifth. In general, in the shade of a house or among trees no shelter (I mean a box affair) is needed at all. This will not be accepted,

probably, but it stands to reason that when a thermometer is in the shade any additional covering will prevent natural ventilation.

Sixth. In the shade of a building or among trees the only sources of error are radiation to a clear sky at night and reflected heat from surrounding objects by day. These two points are continually being insisted upon by theorists, while a few experiments would show them that they are almost inappreciable if the thermometer is on the north wall of the building and there is only greensward in front. In fact, under these circumstances the tendency of a thermometer will be to more than counterbalance terrestrial radiation. The wall of the house will always be cooler than the air by day and warmer than the air at night. These are the principal points, although many other minor ones might be advanced.

My views are, briefly, as follows:

1st. The best exposure for free natural ventilation, least expense, to avoid harmful radiations and reflections, and at the same time to be out of harm's way from cattle, boys, etc., would be on the north side of a tree $1\frac{1}{2}$ feet in diameter and 8 or 9 feet above sod. I would make about three steps—any man could do it without expense—at the foot of the tree, and then put the maximum and minimum thermometers upon a board and screw or nail that to the tree. Of course I do not mean to go into a forest, but I would take an isolated tree either used for shade or in an orchard and convenient to the house. At the top of the board I would put a slanting roof 9 to 10 inches wide to keep off all snow and all rain that does not blow; besides this it would prevent radiation to the sky. I would also put a very light protection on the west side, not more than 6 or 7 inches wide, to prevent the rays of the afternoon sun from striking the bulb. It should be noted that these rays are not so very intense, on account of the low sun, and, in addition, the bulbs being to the left the scale of the thermometer will ward off a part of the heat. If there is no sod underneath, there would be needed a board about a foot wide on the under side to ward off reflected rays. No protection is needed on the east side, for the minimum has been reached before sunrise and the maximum will not be affected till noon or after.

2d. All that has just been said regarding a tree exposure may be applied in so many words to an exposure on the north wall of a building. Here it should be remarked that I have found a continual tendency on the part of amateurs to put thermometers in an angle whenever it could be done. They have thought that the thermometers would be best protected against rain and sometimes wind in an angle. This is true, but the exposure there would be in stagnant air and would be far more objectionable than on a north wall. When there is an L on the north side of a house the exposure should be on the end of that.

3d. Exposure on a wide-extended sod. I do not like this exposure except in a standard shelter, and at least 15 feet above the sod.

Nothing radical should be done without first experimenting upon it. No attention need be paid to the idea that the exposure should be at the average height of a man because we wish to know the temperature where we live or breathe. If the person were going to spend his days and nights right at the thermometer this might be a plausible argument, but as one does not stay there but is continually going from one point out doors where the temperature is high to another 20° or so lower, I do not see the force of this argument. It will be found that all the sources of error are increased the nearer we are to the ground—lack of ventilation, terrestrial radiation, reflection from surroundings, etc.

It would be of great advantage if the Chief of the Bureau or the board on thermometer exposure would initiate a few inexpensive experiments. Place maximum and minimum thermometers upon a board as I have suggested, on the north side of the Weather Bureau office, and 8 or 10 feet above the ground. Also erect upon the greensward, in front, two posts some 10 feet high, and place upon them a board 3 or 4 feet square, and then put on that the additional boards with guards on top, and west, and below. This would be inexpensive, and it might be found more satisfactory than the wall exposure.

One thing should be noted: the temperature found in these locations will not agree exactly with that on the roof. The maximum will be slightly higher and the minimum slightly lower, while the mean of the two will be almost exactly the same in the lower and upper exposures. This will be due not to the error of the exposure but to the fact that the air temperature by day is actually higher in the lower location and by night it is lower.

I will close with a leaf from my experience. My father while preaching at Deerfield, Mass., desired very much to make observations for the New England Meteorological Society. I purchased for him a maximum and minimum outfit and placed it upon a board, as I have suggested, and this board on the north side of the house. While home on vacation I tested this exposure at all hours of the day and night with a sling thermometer, and found the two agreed almost exactly. A careful scrutiny of these observations and comparison with other voluntary records I am sure will show, if anything, a more satisfactory result at Deerfield. Later my father moved to Hartland, Vt., and as my vacation came at that time I set the board upon a maple nearly four feet in diameter. It was in front of a house and about 40 feet away. I feel sure the results here were more satisfactory, if anything, than at Deerfield. Comparisons between the sling and a dry bulb, very near the maximum and minimum, showed the same readings at all hours. I grant that this last

exposure on a knoll, higher than all the village about, gave almost a perfect natural ventilation and could not be improved upon. I can not see how any benefit could possibly arise from inclosing the thermometers in a louver shelter, and I can see that the ventilation would be much impeded. I have considered only maximum and minimum above. If dry and wet are used the dry should be close to the maximum and minimum, *i. e.*, to the east, and the wet should be about five inches from the dry and to its left.

In case a voluntary observer has a Richard thermograph I would put it on a board by itself and make the roof extend a little farther over. I would also put the protecting board against the afternoon sun, three or four feet away, and make it large enough to shade the bulb of the thermograph.

Of course the diurnal range of temperature cannot be obtained accurately except in a standard shelter and far above the ground.

EXPOSURE FROM A WINDOW.

Some observers prefer to read their instruments from a window. Professor Snell, of Amherst, made observations from a window for 40 years, maximum, minimum, wet, and dry. A few precautions will give quite accurate results. First, the top window must be fixed so as to open downwards, so that the heat of the room will go above the thermometers when setting them or when wetting the wet bulb.

Lieutenant Mitchell, of Chicago, Ill., years ago, after trying all sorts of experiments, found this the only relief. One of the panes above the thermometers may be hinged, and this will be the more convenient, as well as enabling the keeping in of the heat in winter. The west blind should be securely fastened at right angles to the house, and if there is any eastward "look" to the north side of the house the east blind should be fastened in the same way. A board stretching across the window should be made fast to the window-posts on either side and should be at least one foot from the window—the farther the better, provided the scales of the thermometer are open enough to be read easily. The thermometers should not be nearer than one foot to the window. If there are inside blinds and the light is not needed, they may be closed, but this precaution will not be needed in most seasons of the year. An exposure of this kind is extremely convenient and ought to give good results if properly managed.

H. A. Hazen.

BIBLIOGRAPHY OF THE SUBJECT.

In Europe, Professor Wild has devoted more attention to this matter than any one else; his papers will be found in the "Repertorium für Meteorologie." In England a few experiments have been tried

with the Stevenson and Wild shelters. An account will be found in the official publications of that country. Papers are as follows:

Professional Paper No. 18, Science, June 8, 1883, p. 502.
American Journal of Science, May, 1884, pp. 365–378.
American Meteorological Journal, January and February, 1885.
Zeitschrift für Meteorologie, February, 1885.
American Meteorological Journal, October, 1885.
American Journal of Science, December, 1885.
American Meteorological Journal, January and June, 1886.
American Meteorological Journal, January, 1888.

APPENDIX.

The suggestions regarding thermometer exposures here given apply to stations north of 35° north latitude. They may apply a little farther south, but it is evident that the conditions markedly change the farther south we go. A sun which is nearly vertical at noon will shine on the north side of a building nearly all day, and the ordinary precautions will not answer. I do not believe in the East Indian custom of building a horizontal thatch six or seven feet square and then exposing the thermometers in the center with no covering on any side. It would seem that reflected heat and lack of ventilation so near the ground would be objectionable. Exposure at the south needs special investigation. I do not see anything better than an open shelter on the roof of a building.

The experience at Key West is very remarkable as showing the great advantage of good natural ventilation. With the shelter on the north side of the building there were about forty-four 90°-days per year during June, July, and August. With the shelter on the roof there is now only .6 of a day (or three days in five years) in the same months.

APPENDIX B.

REPORT OF THE COMMITTEE ON SIGNALS.

WASHINGTON, D. C., *December* 5, 1892

Major H. H. C. DUNWOODY,

President American Association of

State Weather Services, Washington, D. C.:

DEAR SIR: We have the honor to submit the following report of your committee on signals:

In view of the recent change in the manner of issuing weather forecasts many of the defects of the present system of signaling are obviated, as it is not necessary to display a fair weather flag except in very rare cases, and the subject resolves itself into one of warning only; a rain flag covers the ground fairly well. Several different plans have been suggested for changing the present system of signals, but the matter is so important that no radical change is recommended at present.

The ball or cone system has been recommended by several, and it has some advantages, as has also the semaphore, over the flag system. In special localities flash lights or rockets can be used, it is thought, to advantage. The Pusey system has merits that should receive fuller recognition, as it is simple in its action. The Townsend signal is simple and can undoubtedly be used to good effect, especially in localities affected by coal smoke.

There are submitted with this report papers of several distinguished gentlemen whose views will undoubtedly have great weight in making a proper selection. It will be seen from these reports that a majority favor the ball or cone system. The expense in erecting these will not be favorable to their adoption.

The semaphore signal is considered available for agricultural districts as it can be constructed cheaply and placed at regular distances and operated by the farmers so that the information could be promptly transmitted from each center.

The semaphore signals comprise in a measure the Pusey and Townsend signals above mentioned. Flags cannot be used in many localities on account of coal smoke, which quickly obliterates the colors of the flags. Rockets, flash lights, balloons, and cannon are too expensive for regular use.

Very respectfully,

N. B. CONGER,
S. W. GLENN,
R. E. KERKAM,
} *Committee.*

The following papers referred to were submitted by request of the Chief of the Weather Bureau:

WASHINGTON, D. C., *December* 8, 1892.

To the CHIEF OF THE WEATHER BUREAU:

SIR: Referring to the memorandum dated October 25, 189?, requesting that suggestions be made for the improvement of the present system of signaling weather forecasts, I have the honor to submit the following remarks:

The system of flags in use by this service was adopted after careful experiments made by the Indications Board as to the best system of signals, both as to simplicity and visibility. Previous to the adoption of the present system, which depends upon solid colors and position, the flags contained symbols to indicate the weather conditions, these symbols being taken from the Ohio system, which was intended for display on railway trains.

The present system was compared with the drum and cone system by actual test, and in the opinion of the board the flag system proved far superior to the solid symbols. A report of the experiments made by this board will be found in "Extract Number 3, Annual Report of the Chief Signal Officer, 1886," and probably constitutes the only record of an actual test made in this country of the several signals. In all these experiments it has been necessary to provide for at least three elements, viz., fair weather, rain, and temperature, and therefore the system must be more or less complicated. As the present tendency of the service is to allow the absence of the signal to indicate fair weather, it might be well to adopt a system which would only require the display of a rain flag, a local rain flag, and a cold wave flag, thus greatly simplifying the display. I believe the flag to be the best and most practicable signal, owing to its cheapness, although, if funds were available, I would urge the adoption of a semaphore system. It might be possible, also, in localities where electric lights are available, to introduce a flash light in connection with either the storm warnings on the coast, or in connection with approaching storms or cold waves.

Very respectfully,

H. H. C. DUNWOODY,
Major, Signal Corps.

WEATHER BUREAU,
Washington, D. C., October 31, 1892.

To the CHIEF OF THE WEATHER BUREAU:

SIR: In reply to your memorandum of October 25, 1892, relative to weather signals, I have the honor to report that I do not think that any single system of signaling will combine all the features that

are desired, viz., cheapness, durability, simplicity, visibility to a greater distance than flags, drums, and cones, and audibility to a greater distance than whistles.

There is such a large variety of information desired by the public that a complex system of signals seems almost inevitable. The amount of information that is now given by signals, and which is, I think, also the maximum that we should try to give, is enumerated in the following paragraph, and anything more than this should, I think, be given by special telegraph or telephone dispatch which may be bulletined in the telegraph and post offices and printed in the daily newspapers—

Weather prediction.	Flag signal.
1. Clear or fair weather	White flag.
2. Rain or snow	Blue flag.
3. Local rains	Half blue half white.
4. Temperature, higher	Black triangle above.
5. Temperature, lower	Black triangle below.
6. Temperature, stationary	Black triangle absent.
7. Cold wave	White flag, black center.
8. Storm flag for special States (blizzards or high winds, snow, and freezing)	Red flag, black center.
9. Storm flag for all seaboard and lake stations (dangerous winds)	Red flag, black center.
10. Direction of storm wind, northwest	White pennant above.
11. Direction of storm wind, southwest	White pennant below.
12. Direction of storm wind, northeast	Red pennant above.
13. Direction of storm wind, southeast	Red pennant below.
14. Cautionary flag for lake stations	Red flag, white center.
15. Direction of cautionary winds, northwest	White pennant above.
16. Direction of cautionary winds, southwest	White pennant below.
17. Direction of cautionary winds, northeast	Red pennant above.
18. Direction of cautionary winds, southeast	Red pennant below.
19. Information signal	Red pennant alone.
20. Frost at special stations	White flag, black center.

In order to diminish the number of signals as much as possible, I recommend that Nos. 4, 5, and 6 of this list be omitted, and that temperature predictions be signaled only when the temperature experiences a decided rise or fall; a decided rise is so rarely injurious that at present it is not worth signaling; a decided fall is only injurious in the special cases of cold waves, blizzards, and severe frosts, and these three I would provide for by special signals, namely, "cold wave," as now in No. 7; "blizzards," as now in No. 8, only I would make it a red flag and black border so as not to be so precisely like No. 9; and for "frosts," No. 20, I would substitute the black triangle

as now used in Nos. 4, 5, and 6, but of course putting it below any other signal so as to show that lower temperature is predicted.

The system of items to be signaled is thus reduced from 20 to 17, and the confusion between cold wave and frost, or between blizzard and storm flags, is removed, and a special flag signal for frost is provided.

The remaining 17 items are signaled by means of combinations of 10 different flags, namely:

(a) The white flag.
(b) The blue flag.
(c) Half blue and half white.
(d) White flag and black center.
(e) Red flag and black center.
(f) Red flag and white center.
(g) Red flag and black border.
(h) White pennant.
(i) Red pennant.
(j) Black triangle.

As regards other kinds of signals than flags, I think that if any changes be made they should be in the direction of the "ball, cone, and drum" system, since that is already in use by almost every other nation, but as it would have to be elaborated in order to provide for our 17 items of information, I think it important that only such elaboration should be adopted as is likely to be acceptable to all nations since it is, of course, very desirable that the navigator should find the same system in use at whatever port he may be. As these signals are cumbersome and expensive I would especially direct attention to the utilization of the "semaphore," as used at most naval and mercantile stations throughout the world for telegraphic communication. Semaphores were first established by the French in 1794, and immediately adopted by the English, and are still used wherever the electric telegraph or telephone has not superseded them. Portable semaphores are erected on vessels for communication with shore, and are especially useful when the wind is too feeble to shake out the flag signals. For our purposes the semaphore would consist of a strong mast to which there are attached two arms which are so hinged to the mast that they can be set at any angle by the man who works the ropes at the bottom of the mast. At night these arms carry green, yellow, and red lights. Each arm can be put into five positions, namely, hanging, horizontal, vertical, inclined up, or inclined down, and the combination of the ten positions thus made possible gives an abundant variety of signals. These semaphoric signals are, of course, set up so as to face in the direction that is most important and are equally visible from behind as well as from in front. In some cases we should need to set up another mast with

duplicate signals facing at right angles to those on the main mast; the color of the arms of the semaphore will depend upon the background. Thus the signals may be easily and correctly read over the entire region surrounding the semaphore.

If it be practicable to introduce a system radically different from flags and semaphores, then the one that is simplest, cheapest, and thoroughly practical is that which was developed at the Agricultural College at Orono, Me., and which I will call the "staff and balls" system. In this we have at least three balls made of light material painted black and white so as to be easily visible, and whose use as signals depends upon the fact that they have different sizes, for instance, 1, 2, and 4 feet in diameter, respectively, if three balls are used; or 1, 2, 3, and 6 feet if four balls are used. These balls are strung one above the other vertically on the staff; the order in which the balls come as read from above downwards is subject to a large number of combinations, so that with three balls fifteen different predictions may be indicated, the signification of each combination being wholly arbitrary. The balls should, of course, be made of thin slabs or lattice work so as to combine lightness, stiffness, and least resistance to the wind. The most expensive part of this system is the mast and the apparatus for raising and lowering the balls.

In order to make our flag or other signals visible over a wider range of country it is, I think, important to duplicate them at many points surrounding a large city or harbor, and to elevate them higher above the ground than we usually do; this is especially necessary at large ports like New York where myriads of flags and lights surround and obscure our own signals. Progress in meteorology has been greatly forwarded by continuous records from the summit of the Eiffel Tower, and wherever we can obtain the use of similar tall towers for our instruments and signals, there will be a corresponding benefit both to meteorology and to the display of signals.

With regard to signals distributed by means of whistles, bells, and other sounds, I know of nothing better than the steam whistle for those who are within three or four miles of the whistle, and have no other confusing sounds to bother them. But in the cities, where other noises daily obscure the whistle, and where the telegraph and telephone are widely distributed, it should become possible to utilize these latter as well as the city fire-alarm system to disseminate the 11 a. m. prediction daily bell signals, just as the midday time signal is distributed throughout the whole city simultaneously. For instance, adopting a system of bell strokes similar to the long and short whistles, and desiring to communicate to the citizens of Washington the fact that a "cold wave" is expected, the fire-alarm system would, at 11 a. m., be operated from the Weather Bureau, and every gong and bell in the city would ring first a long "Weather Bureau attention call," being a

succession of strokes as rapidly as possible for 15 seconds; after this comes a pause and then three sets of rapid strokes (three individual strokes in each set), corresponding to the three short blasts of the whistle. If, however, "fair weather" is to be signaled, then after the "attention call" has been sounded there would come simply one long signal made up of strokes of the bell in rapid succession, lasting for about 5 seconds. In this way we should strike on the fire-alarm gongs in every city where we have an office the same weather signals that are given by the whistles and the signal flags. If now, in addition to this, we display our flag signals at the same time and for an hour or two thereafter at the fire-engine houses, we shall have fully communicated to the people of the cities, before 1 o'clock daily, our ideas as to the coming weather. This utilization of the public fire-alarm system will be especially important if we desire to predict a matter of urgent importance, such as cold waves, blizzards, thunderstorms, and tornadoes.

It will become a regular habit of the people to listen for the 11 a. m. weather signal as they now listen for the 12 o'clock noon signal.

Respectfully,

CLEVELAND ABBE, *Professor.*

WEATHER BUREAU, *October* 31, 1892.

To the CHIEF OF THE WEATHER BUREAU:

SIR: In response to memorandum of October 25, 1892, calling for a report upon a better method of disseminating weather forecasts than that now adopted, I desire to say:

There are at least three methods to be considered, and the one to be chosen, it seems to me, depends as much upon the desires of any community as on any thing.

1st. Visible signals.

2d. Audible signals.

3d. A message to be posted at the post office or other central point from which carriers or criers may distribute the message by horseback, bicycle, or otherwise.

VISIBLE SIGNALS.

For a visible signal I would suggest a dense smoke to be made upon a knoll at a specified time. A white smoke to indicate fair weather or no rain for 24 or 36 hours, as the case may be. A dense black smoke to indicate rain. The smoke should ascend to a considerable height above the trees in a wooded country. If difficulty is experienced in making this visible to low lying districts the smoke may be started in a tree by climbing up a ladder, or in a level country the furnace or smoke producer may be placed upon the roof of a house. Persons

interested would very quickly learn where the signal could be seen and would post some one in a position to look for it at the proper time. The duration of the signal is a detail to be decided upon after a little experience and to suit the needs of those interested. I do not now see any difficulty in making the signal *intermittent* for temperature, that is, I would close the furnace or smoke producer momentarily and then open it. The intermittent white smoke would indicate higher, and black, lower temperature.

There is another method which may be simpler yet. Let the duration of the smoke indicate the character of the forecasts, like the flash light in a lighthouse.

For example, *fair* weather, no rain: a white smoke to be seen 1 minute, no smoke, one-half minute; smoke 1 minute, no smoke one-half minute; smoke 1 minute, no smoke one-half minute, three times, and a glance at the watch will show what this means. Persons can tell this, however, without a watch after a little experience, by counting 60. For *rain* I would suggest the same smoke continued for 2 minutes with a gap of 1 minute, three times as before. For *higher* temperature white smoke as for *fair* above, and *lower* temperature the same as rain but with black smoke. This system may be greatly extended. The substances used need not be very expensive; probably they would not cost more than two or three cents each time.

AUDIBLE SIGNALS.

Audible signals would be needed in a hilly country and in dense fog. I would suggest the use of the church bells. These are distributed over the whole country at distances of four or five miles and there are few people who would use the forecasts who are out of hearing of a bell. I do not think there would be much objection to the use of a bell for heralding natures changes provided there are not too many failures in the forecasts. The details of the use of the bell may be easily worked out and very quickly learned by the bell ringer. Church bells are used in this city for the fire alarm, and surely they would be more appropriate for signaling the weather. I would suggest two strokes thrice repeated for fair, three strokes thrice repeated for rain, four strokes thrice repeated for higher temperature, and five strokes thrice for lower. If there is objection to the use of the bell in some cities, owing to its being mistaken for a fire alarm, it will be a very simple matter to settle upon some conventional ringing, as a preface to the forecast, which can always indicate that the probable weather was about to be indicated. I think the definite time of the signal, however, would very quickly impress itself upon the mind and there would be no confusion. It should be noted that this signal would need to be heard only once and not three times to show what it meant.

As an illustration, I note that in this city some churches give three strokes four times repeated each morning at 6 o'clock, and there is no confusion; also, the fire alarm never repeats the same number of strokes.

Another system would be by explosives, but I suppose this may come under the head of rockets, which have already been under advisement. Were it not for the expense and a slight danger connected with this method I think it might be made to supersede all other systems.

The most important thing just now is to improve the forecasts. There is no doubt in my mind that every community where weather forecasts are of value would very quickly devise a permanent system for distribution if it found that the predictions could be depended upon. I would suggest that a carefully worded statement containing the various systems proposed be drawn up in circular form and sent to any community where complaints have arisen or where weather forecasts are desired. Most villages have a flagstaff near the center of the town. At night a Coston signal light might be burned at proper intervals and a sufficient number of times, as has been suggested above for smoke.

I have thought that attention might be attracted to the signal by a loud explosion, from a mortar or otherwise, which need not entail very great expense, just before the regular signal was displayed or sounded. All these matters of detail may be easily arranged after experience and when it is known what can be used to best advantage.

There is one other suggestion. In Pomfret, Vt., there is an enormous tin horn some 20 or 25 feet in length, the volume of sound emanating from this horn is marvellous though blown by lung power. I have no doubt that some device of this kind might be greatly improved upon, and I think it could be heard easily over an area of 40 or 50 square miles. I have heard it 3 miles.

Yours, very respectfully,

H. A. Hazen.

Washington, D. C., *October* 29, 1892.

To the Chief of the Weather Bureau:

Referring to your memorandum of October 25, calling for a report of suggestions of more effectual means for the dissemination of weather warnings, I desire to submit the following remarks:

In your memorandum you have referred in detail to several methods either now used or that have been suggested as useful in this connection and which you say have been thoroughly discussed and are, therefore, debarred from further consideration. In view of this I would say that there appears to be but three methods by which in-

formation can be disseminated or acquired. That is to say, an individual may learn a thing which another wishes to impart to him either by *seeing* some signal previously arranged upon, or by *hearing* some sound serving as a signal, or he may receive a personal message, which may come to him in a variety of ways.

It seems to me we are confined to one or all of these three methods for disseminating our information. It does not appear to me to be practicable to expect to so improve or extend any of the methods of dissemination depending upon seeing or hearing as to reach a larger class of people than are now reached by those methods. We must depend more, I think, upon the wide dissemination of special messages into remoter regions. These messages have the great advantage of always being more complete and explicit than signals can ever be. Their expense, however, is of course a matter of serious consideration. It is necessary, too, that messages be delivered with great promptness, which implies the use of either telephone or telegraph lines.

There does not appear to be any serious obstacle to sending every community interested in the information some more or less complete message of weather forecasts, and then resorting to the display of signals for the further dissemination to those not already reached. There is little doubt that in many individual cases persons who have any interest in the matter, whatever, can find some means peculiar to their particular circumstances by which they can get regular reports from some adjacent center.

This problem presents extreme difficulties for which I find no satisfactory solution.

Respectfully,

C. F. Marvin,
Professor, in charge Instrument Room.

October 27, 1892.

To Prof. M. W. Harrington:

In regard to the subject of signaling forecasts otherwise than by telegraph and telephone, the following suggestions are offered:

The best method in any particular instance will depend on the locality, what things are to be signaled, and the distance the message is to be transmitted.

Whether the expense of signaling is to be borne by the Weather Bureau or by the communities interested in any special kind of warnings ought to determine largely what method of signaling should be used.

For harbors, where signals are usually viewed at short distances, the cone, cylinder, and sphere constitute the best means of signaling. These symbols have now acquired a definite meteorological significance, their character is established, and they are not used for anything else.

They are separate and distinct from quarantine flags, revenue marine flags, signaling flags, and gala devices of all kinds, and it is considered should be adopted for harbor display.

For population centers inland, in cities and villages where people are clustered in a small area, flags are considered to be the best signaling device.

For long distance signaling where wires are not available, the method to be used ought to depend on who pays for it. If interested communities are willing to bear the expense, the method of carrier pigeons would seem to be the best and surest method of sending messages for distances of five to one hundred miles. It is not recommended that this method be expanded at Weather Bureau expense. If persons interested in specific warnings are willing to pay for the transportation and care of pigeons, which would not be very great, the Weather Bureau could afford to mount them. As a rule, if people are not willing to pay for a thing they have not much use or desire for it, and it ought not to be forced on them.

It might be well to test the feasibility of long distance signaling for special localities by powder flashes. Flashes of half a pound of powder can be seen on clear nights at distances of 50 to 100 miles. The stations have to be intervisible. Probably on cloudy nights places need not be intervisible to have the flashes seen. The flash might possibly be made to carry green or red colors by having the powder contain minute quantities of barium and strontium.

A good plan would be to have an agreed time for making such signals, say 11 p. m., in the case of cold waves, for instance, and the flashes half a minute apart for 10 minutes.

Some experiments might be made on this line, or persons who have done such flashing might be written to. For distant signaling by daylight something might be done by sunlight flashing.

Stations in this case would have to be intervisible and the sky clear. A mirror might be mounted on an automatic whirling device, either by a spring or weight to be wound up or turned by the wind. The mechanism could be made to change the inclination of the mirror to the horizon half a degree at every revolution. This would insure a flash being seen at every part of the horizon at intervals of a minute or so. Such flashes are very readily distinguishable over very great distances.

Very respectfully,

T. Russell.

WASHINGTON, D. C., *October* 26, 1892.

Prof. M. W. HARRINGTON,

Chief of the Weather Bureau:

MY DEAR SIR: Replying to your instructions of the 25th instant, in which you ask me to submit plans for an improved long-distance method of signaling, I am bound to confess, at the outset, that the question is one in which the experience of the practical meteorologist will have every advantage over me.

Nevertheless, I should like to urge at as early a date as possible the use of the "Ballon Captif" in connection with the weather service. It appears to me that the present opportunity is particularly well timed for broaching the matter definitely. I do not aim to offer anything original, my object being rather to present a neglected but feasible experiment.

1. I see no reason why a suitable balloon, a connecting wire, and an efficient reel can not be made at a small expense. Doubtless some preliminary experimentation will be necessary, the object being to devise a form such, that if the balloon is lost, the expense will only be trifling.

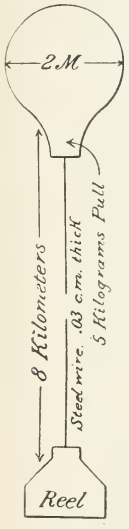


FIG. 5.

To obtain some notion of the conditions involved I will take a homogeneous atmosphere, at 0° C. and 760 *mm.*, a balloon filled with hydrogen, and a steel wire as a tether.

A balloon something over 6 feet, *i. e.*, 2 meters, in diameter, will sustain 5 kilogrammes. This is below the strength of a steel wire $\frac{3}{10}$ millimeters in diameter (sustains 6 *kg.*). Ten kilometers (about 6 miles) of such wire will only weigh 6 kilogrammes.

Hence in a homogeneous, quiet atmosphere such a balloon, if weightless, will go up, say 5 miles, without breaking its cord. Of course the actual case (winds, decreased density of air, etc.) is much more unfavorable, but the margin is large enough to make the experiment worth while. Even a half mile of ascent would offer experimental advantages. Making allowance, however, for the hypsometric correction the ascent of the weightless balloon on the steel wire given should be $8 \div 3.5$ kilometers, or $1\frac{4}{10}$ miles.*

2. *Uses.*—The uses of such a balloon are manifold.

a. It could be colored or shaped in such a way as to be available for signaling forecasts. Here its size is both in favor of visibility and buoyancy.

b. It would be particularly useful for investigating the atmospheric electrical potential, both as regards time and space distribution. (McAdie, Bigelow.)

*The wire being here superfluously strong the excess of weight can be reckoned as weight of the balloon. Silicon bronze wire, which is nearly as strong as steel and free from rust, would be preferred.

c. It would be of service in mapping out changes of temperature and possibly of pressure on passing from the surface of the earth upward.

d. Finally it would furnish some clues on the motion of upper aerial currents.

3. *Instruments.*—Electrometers suitable for the registry of atmospheric potentials need not be expensive instruments.

A device for anemometry has occurred to me, as follows: The *whistling* made by the wind in passing across a fine wire, *ab*, takes place in accordance with laws which have been exhaustively investigated by Dr. Strouhal. So long as the periods of vibration of the wire are avoided the pitch of the note can be sharply expressed as a function of the speed of the wind. Suppose now such a wire, *ab*, is soldered to the plate of a telephone as in Fig. 6. Then the note can be transmitted to any distance by the telephonic wires, *cd*. This, therefore, is a simple device for anemometry, since the wires are available for transmitting the air potentials and for "captivating" the balloon. Doubtless other means of registry will suggest themselves.

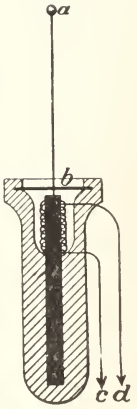


FIG. 6.

4. *General remarks.*—Considering, therefore, the number of uses to which such a balloon can be put, and remembering that some mode of exploring the upper atmosphere *must* be adopted by meteorologists, eventually; remembering too that observations should preferably be made remote from mountains and hills (for the occurrence of earth protuberances of this kind can hardly be without influence in modifying the normal aerial phenomena) the experiment does not seem to be visionary. I am aware, of course, that it is not novel, but it has not, to my knowledge, been reduced to a practical basis.

The construction of a balloon answering the purposes in question is a legitimate laboratory experiment. Parchmentized tissue paper, such as is now much used by draughtsmen, suggests itself for the purpose, since it is toughened and becomes more impervious by exposure to moisture. In fair weather the balloon could be made larger and sent higher. In stormy weather it would have to be smaller, stronger, and more stoutly tethered, and it would not mount as high. If color is an insufficient means of signaling, the form of the balloon is equally capable of variation. Even if untethered, the instrument for signaling would still be an instrument of research in the hands of the meteorologist.

Very respectfully, yours,

C. BARUS, *Physicist.*

WASHINGTON, D. C., *November* 4, 1892.

Prof. MARK W. HARRINGTON,

Chief of the Weather Bureau:

DEAR SIR: Referring to your memorandum bearing date of the 25th ultimo, with request for opinions and suggestions looking to a more perfect system of signaling forecasts, with special reference to the outlying agricultural districts, distant from cities and towns by from 5 to 25 miles, I beg leave to submit the following:

During the present year it has been my privilege, in the line of duty, to attend a considerable number of farmer's gatherings in widely separated States of our Union. Coming thus in close touch with so many who are directly concerned in the matter, I had frequent opportunities for noting the work of the present system of signaling and for hearing from those who were more or less benefited by the service.

I have found that the efforts made during the year to extend the benefits of the Bureau in the rural districts are heartily appreciated. A general interest prevails among the farmers to learn more of the methods of work of the Weather Bureau, and a desire to avail themselves of its advantages. Those who have been so favorably situated that they could promptly receive the forecasts are enthusiastic in their appreciation of the work and its great value in their farming operations.

Upon the present lines of work, and with the methods of signaling now in use, there yet remains a large amount of uncovered territory.

In some sections, through concerted action of farmers, fruit and vegetable growers, and others, the use of a cannon, specially for frost warnings, has proven satisfactory. In some localities this method of signaling, if not already tested for more general use, might be at least experimentally extended.

I am more and more convinced, as I go over the field and consider the whole situation, that the full benefits of the Weather Bureau service can never be received by the great majority of our farmers, and by the dwellers in remote villages and hamlets, until one or both of the following steps of progress are taken.

1st. The establishment of at least one Government telegraph or telephone station in each county of the United States, and, if possible, this central station—which may very properly be the county seat—should be in connection by telephone with each *local* post office in the county. To this central station the Washington, D. C., general and State local forecasts should be promptly forwarded at least twice in twenty-four hours, with provision for "extras," such as "cold waves," frosts, local storms, etc. With the prospective expiration of the general patents on the telephone, the instruments will be greatly cheapened, and there is scarcely a neighborhood where the farmers

would not co-operate in purchasing the instruments and erecting the few miles of poles and wires needed to connect their houses directly with the local post office, or, if need be, with the central station at the county seat; not only to receive the great benefit of the prompt receipt of the weather forecasts, but for all the many other advantages which close contact with the markets and the events of the world of the day would afford them.

2d. A general and systematic extension of the rural free delivery of the mails, by which the farmers along these country post routes could receive either their daily paper containing the forecasts or a special farmers' weather bulletin sent out from the nearest local Weather Bureau station. Or this rural mail carrier might have displayed upon his wagon, horse, bicycle, or pouch, a flag, or other signals furnished him each day at his starting point.

I believe that as the great benefits farmers, who are so much dependent upon the weather for their success, can derive from the Weather Bureau service become better and more generally known, that a public sentiment and demand will be created which will eventually result in one and probably both of the above suggested plans. To this end every effort should be made to extend and perfect the present system as far as possible, every new locality reached by flags or whistles becoming the leaven that will in the near future leaven the whole lump.

Very respectfully,

MORTIMER WHITEHEAD, *Inspector.*

WASHINGTON, D. C., *October* 31, 1892.

To the CHIEF OF THE WEATHER BUREAU:

SIR: Replying to memorandum dated October 25, I have the honor to state my belief that no system of *visual* signals can possibly be devised that will meet the various requirements of communicating the forecasts to the "outlying agricultural districts." The cost alone is an insurmountable obstacle unless those directly benefited will bear the expense. The same would probably prove to be the case with any system of *sound* signals, though it might be well to investigate the probable cost of announcing forecasts of *severe* storms or *severe* cold by means of explosives set off in the early evening (say about 6 o'clock) when the warnings are to be given for the next day. A few pounds of some quick burning explosive suitably placed, or confined so as to produce vibrations in both air and earth, would give warning to a very extensive area, and in such manner as to attract attention from all persons within the radius of vibration. I would suggest one explosion for rain or snow storm, two explosions in quick succession for *severe* storm with rain or snow, and two explosions with 15 or 20 seconds interval

for severe and sudden fall in temperature, or for frost. I think any system of weather signals should announce only the unusual and abnormal features; the absence of the signal should indicate "fair," or that "nothing unusual will occur."

As to the daily announcement and dissemination of the 36-hour general forecasts for the benefit of the agricultural districts, I believe it can only be successfully accomplished through and with the hearty co-operation of the Post Office Department and by means of the press.

Nearly all farmers in these days, especially those near small villages or towns, visit or send to the nearest post office every day, and a very large percentage of them read a daily paper. I therefore suggest:

1st. An appropriation (specific) for the necessary telegraph and telephone messages (nearly every region can now be reached by one or the other).

2d. Furnish each postmaster with a simple announcement by wire of the probable weather for the next day in the fewest possible words. Thus: "Monday 31, rain;" or "Monday, 31, rain in afternoon;" etc. The date might be omitted, perhaps, and simply the day of week used. Let it be understood that the absence of the telegraphic message shall mean "fair," and the cost can be much reduced.

Then provide large sheets with suitable head lines on which the postmaster shall write, *with crayon*, the weather announcement, and post it on the regular bulletin boards of the post office.

Let it be once *well understood* by the farmers that the Government daily telegraphs the forecasts to each post office, and the people will generally avail themselves of the opportunity thus given to know of coming changes in weather.

Very respectfully, your obedient servant,

B. M. PURSSELL,
First Lieutenant, 19th Infantry.

WASHINGTON, D. C., *October* 28, 1892.

To the CHIEF OF THE WEATHER BUREAU:

SIR: Referring to memorandum dated the 25th instant, reciting defective features of the present systems of weather forecast signals, and calling for opinions and suggestions calculated to remedy the defects, and also to extend the benefits of the forecasts to agricultural districts remote from telegraph and telephone lines, I have the honor to report as follows:

DISPLAY SIGNALS.

Flag signals are, in my opinion and experience, very unsatisfactory. Few persons know or remember the combinations, and the system is expensive.

Whistle signals have the same objection as regards the combinations, and, in addition, they cannot be depended upon for large areas, owing to variability of wind direction.

The ball, drum, and cone system is, in my opinion, the best. Form and not color must be depended upon for satisfactory service. The distinctiveness of the signals of this system is independent of the wind force and direction, and they do not become indistinguishable as a result of deposits of dirt, soot, etc. They are also durable, and, unlike the flags, there would not be a constant expense for new material.

TRANSMISSION OF FORECASTS.

The mail service can be utilized only for small areas about the map or bulletin distributing centers. The telegraph and telephone present the only medium of communication with districts remote from forecasting stations.

In my opinion the greatest possible number of post offices having telegraphic or telephonic communication should be made display stations. Co-operation with the Post Office Department would make the prompt display of signals and the care of the signal material a part of the official duty of the postmaster.

SUGGESTION.

My suggestion for improving the system with the facilities at present available is that form signals, say the ball, drum, and cone, be used instead of flags. I would also suggest that in case the Post Office Department can be induced to co-operate, form signals and the apparatus necessary for their display be furnished postmasters who can be reached by telegraph or telephone, and that signals be displayed upon postal cars.

By this plan the weather signal system would be co-extensive with the growth of the telegraph, telephone, and railway lines. The postal car signals would reach many districts remote from telegraph offices and towns or villages early in the day. These signals could be placed, if necessary, by observers at forecasting centers.

Very respectfully,

E. B. Garriott.